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GAILLIMH

NATIONAL UNIVERSITY OF IRELAND
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SUMMER EXAMINATIONS 2001

Unit EP329- Physics of the Environment II

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Time allowed: ONE AND A HALF hours.	Answer THREE questions, at least one from Section A and one from Section B

EP329 – Physics of the Environment II

Section A

Q.1 Briefly describe the fluidised bed furnace, and outline its advantages, compared to a conventional furnace. [3 marks]

A town in a developing country is given two donations by an international charity:
(a) A methane burner for electricity generation (for simplicity, assume 100% efficient)
(b) The capital costs required to build an anaerobic digester for the town's animal waste, to supply the methane to the generator.

The power produced from the installation of digester and generator will be used to supply the lighting requirement for the community: this is equivalent to 6,000 lamps, of 60 W each, which operate for 6 hours per day.

If burning methane produces 55 MJ per kg, how many kg of methane will be required annually to supply the generator?

If the capital cost associated with the installation of digester and generator is estimated at £1250 per kW, what is the minimum contribution required from the charity?

Assuming that the digester produces no CO_2, how many kg of CO_2 will evolve annually from the digester/generator installation? [7 marks]

p.t.o.

Q.2 Answer (a), (b) *and* (c)

(a) Outline the basic operating principles of a fuel cell, and explain why there are particular advantages associated with fuel cells that operate at high temperature. [4 marks]

(b) A wind-farm has 200 wind turbines, each with blade diameter of 50 m. Estimate the power that can be generated by the farm at a time when the wind speed is 10 m s^{-1}. Assume that the wind turbines have an efficiency of 15%, and that the density of air is 1.3 kg m^{-3}. [4 marks]

Briefly explain the function of (i) the control rods and (ii) the moderator in a nuclear reactor. [2 marks]

Q.3 To calculate the *predicted mean vote* in a thermal exposure assessment, the metabolic rate and clothing characteristics of room occupants must be estimated, and the air temperature, relative humidity, and two other environmental variables must be measured. What are these variables? [3 marks]

A house has a total window area of 15 m^2 and a ceiling area of 98 m^2, and the respective thermal transmittance (U-values) for the glazing and the ceiling are 5.4 $Wm^{-2} K^{-1}$ and 0.35 $W m^{-2} K^{-1}$. When the indoor temperature is 20°C and the outdoor temperature is 5°C, the rate of heat loss from the house is 3197 Watts. Calculate the effect on total heat loss of the following measures (for the same indoor/outdoor temperature gradient)

(a) replacing the windows with double glazing (U-value = 1.9 $Wm^{-2} K^{-1}$)

(b) adding additional insulation so that the U-value for the ceiling is 0.2 $Wm^{-2} K^{-1}$ [7 marks]

Section B

Q.4 Give the general principles involved in radiation protection from gamma ray sources. [4 marks]

An office worker is situated at a distance of 4 m from a 18500 MBq (500 mCi) source of cobalt-60 and resides there for 1500 hr per year. What thickness of lead shielding would be required for protection.

Gamma constant for cobalt-60; $\Gamma = 34 \times 10^{-4}$ $Sv.m^2/MBq.hr$
Half value layer in lead for cobalt-60 is 1.2 cm.
Tenth value layer in lead for cobalt-60 is 4.0 cm. [6 marks]

Q.5 Write notes on <u>three</u> of the following: [10 marks]

(a) Types of radiation detectors worn for personnel monitoring.
(b) The chart of nuclides. Also show the parent daughter positions in alpha and beta decay.
(c) The Geiger counter.
(d) Biological effects of ionising radiation.
(e) The absorption processes of gamma rays in matter.